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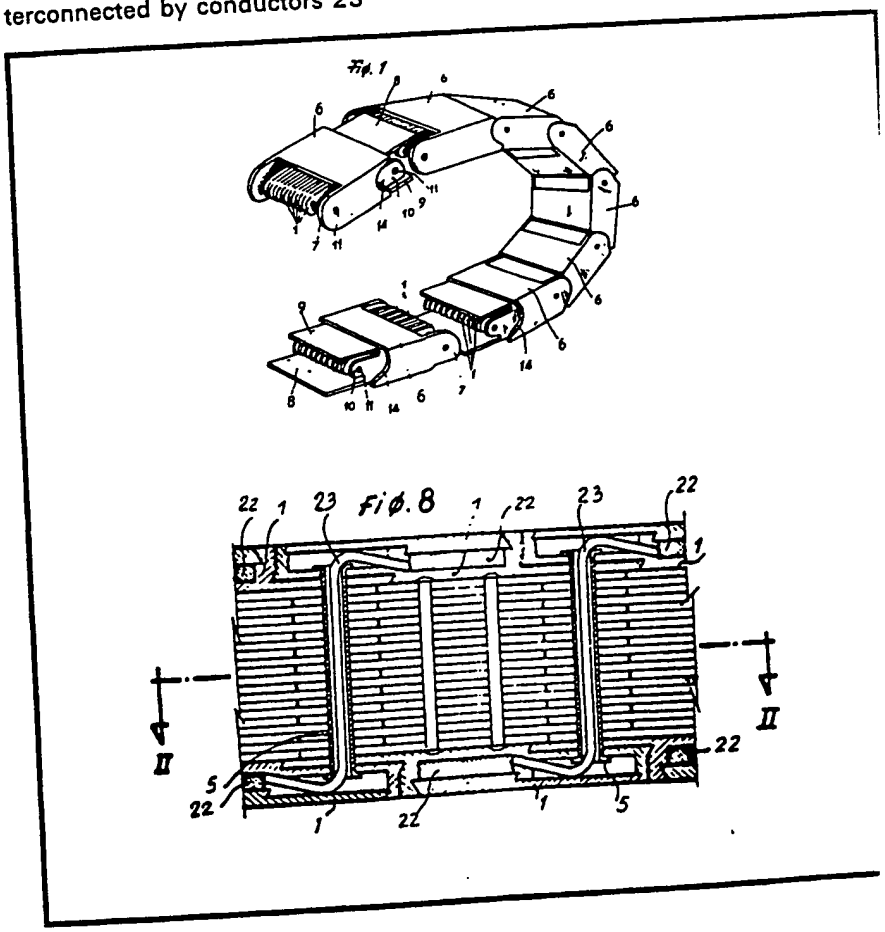
(54) Construction of magnetic cores

(57) A flexible articulated magnetic core for a current transformer comprises a chain or belt having a series of identical links each of which comprises a row of metal plates 1 in Fig. 1 which are pivotally connected together and to the plates of adjacent links by transverse rivets 5. Each plate 1 has a convex and a concave end which complement those of adjacent links and in alternate rows the plate direction reverses to provide overlap. Coupling members (Figs. 6 and 7 not shown) at the ends of the chain include magnets which unite to form a closed ring round a cable under test. Polyamide sheaths 6 surround each link. Individual coils 22 may surround each link, these being interconnected by conductors 23 passing through the pivots 5. Electric/magnetic shields (24) may be provided.



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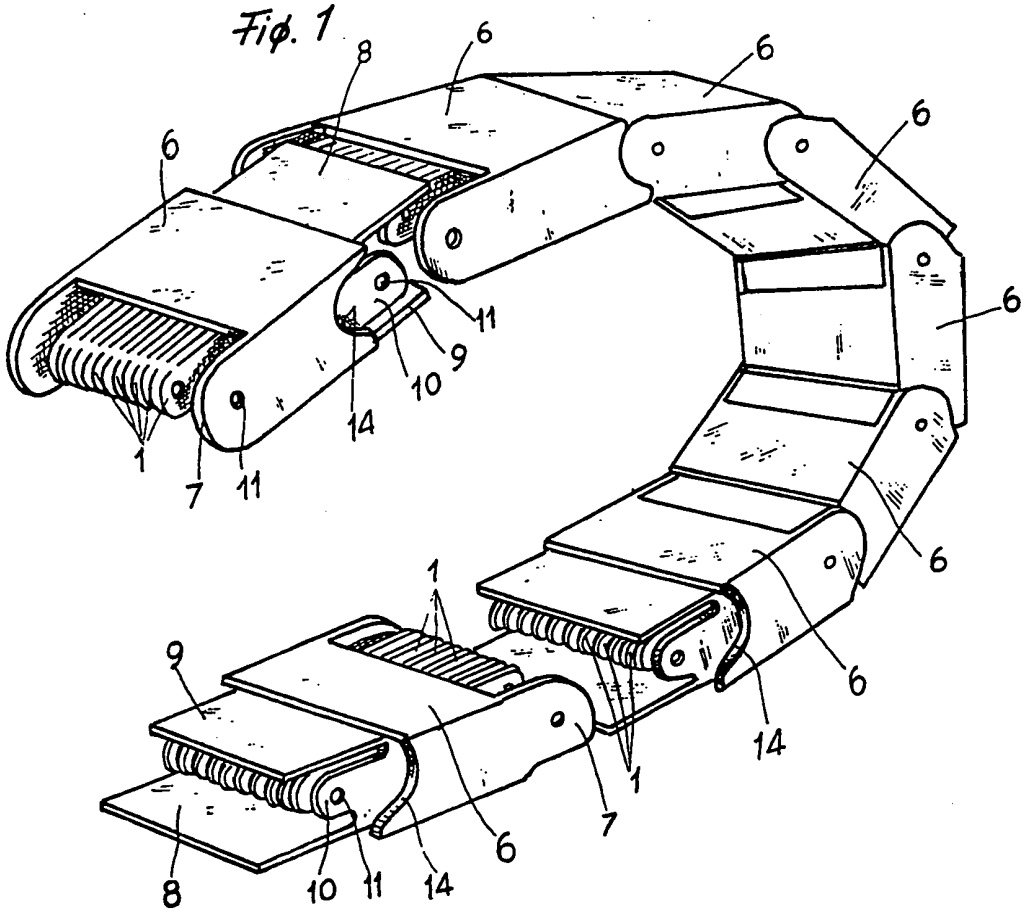

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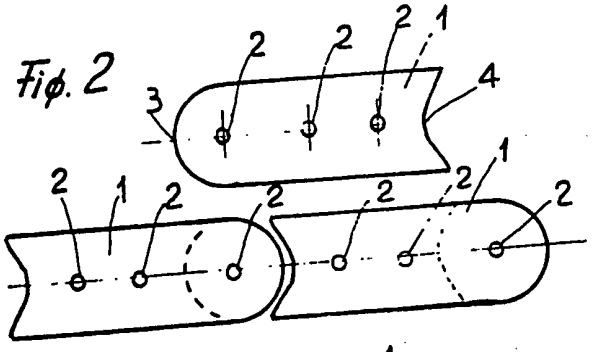

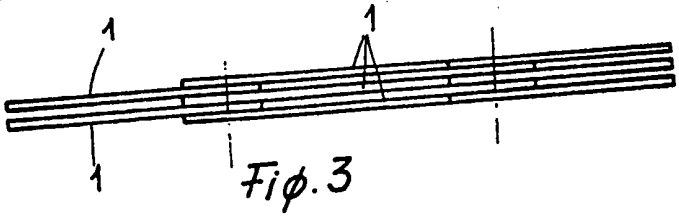

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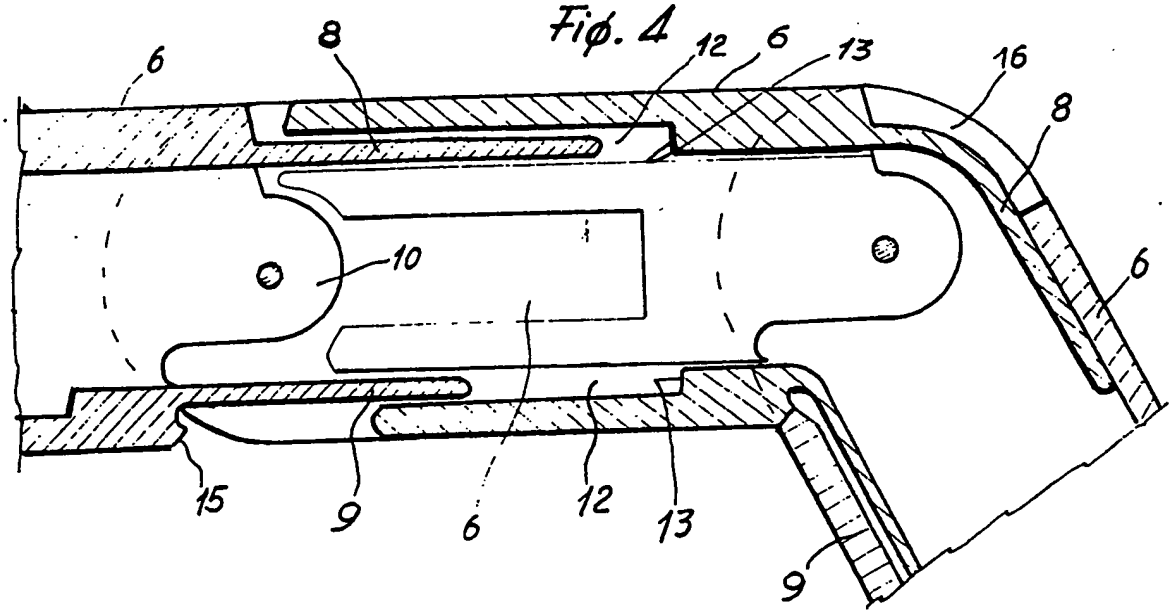

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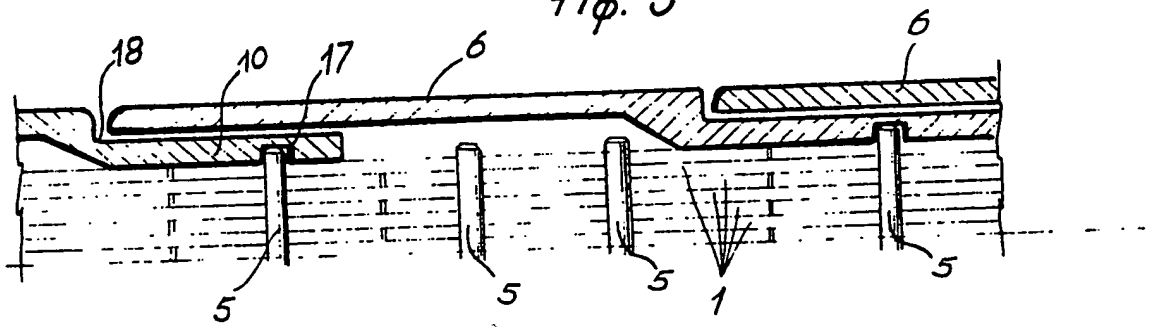

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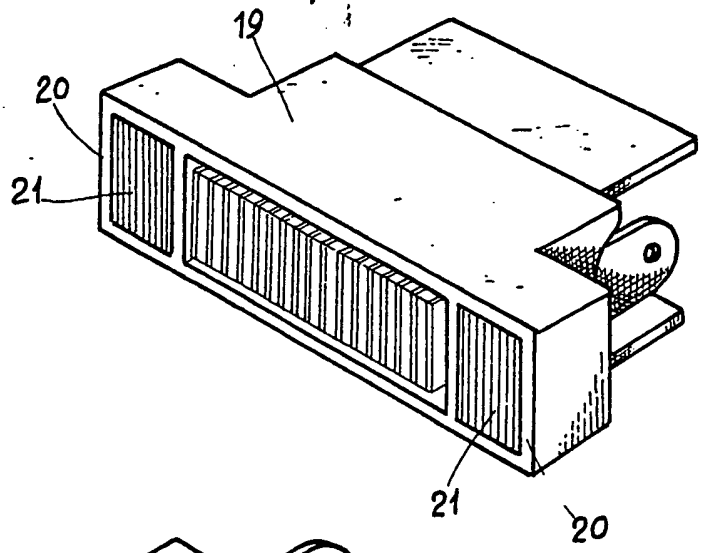
Fig. 6



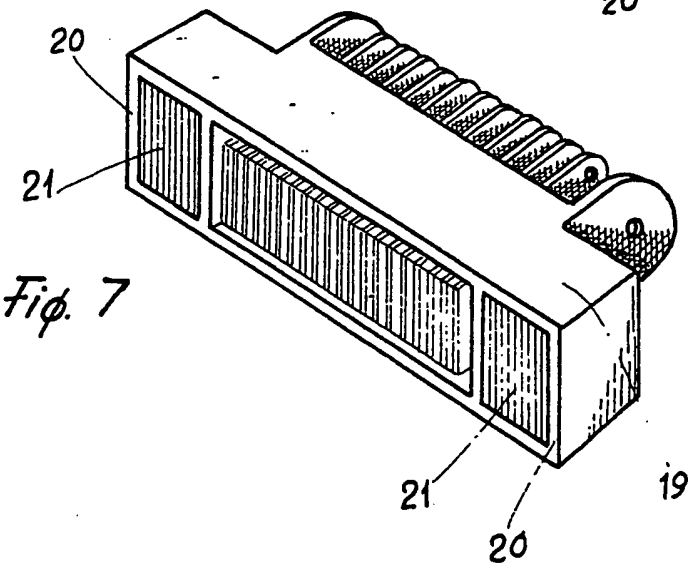


Fig. 7

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Fig. 8

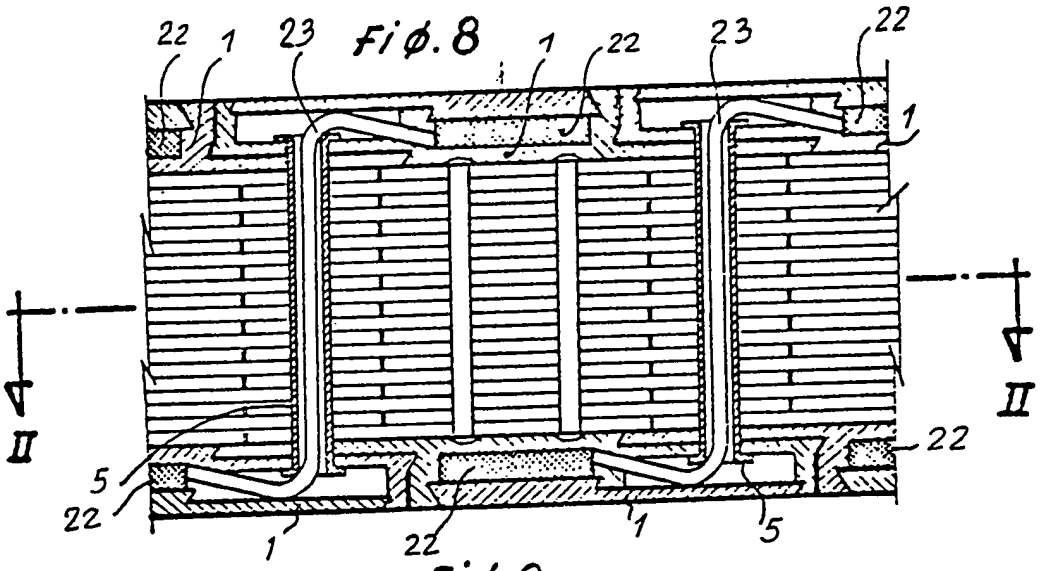
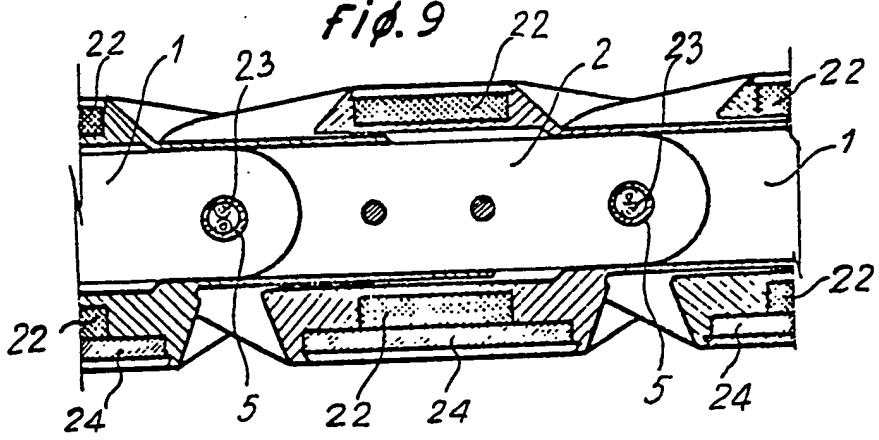


Fig. 9



SPECIFICATION

Construction of magnetic cores

This present invention relates to th construction of flexible and articulated magnetic cores.

At present, magnetic cores are usually either of rigid construction or are rigid with an opening and closing joint. The first type constitutes a juxtaposition or superposition of rigid metallic plates, rigidly secured to one another, without possibility of relative movement by means of a metal bolt which connects and holds them together. The second type is made up of a rigid magnetic metal parts forming a flange or brace with a single articulation point for both jaws.

This latter design serves the purpose for which said magnetic cores have been constructed but is of no use when the core needs to be articulated and flexible, as for example, a magnetic core for the detection of buried electric cables in close proximity to one another, in order to check if one of them carries an electric current. The core, being in the form of a bit, requires a larger space than that normally existing between the conductors to be detected in order to pass between them.

Logically, this function cannot be fulfilled with the magnetic cores at present in existence. The object of this invention is to enable flexible, articulated magnetic cores to be obtained which comprise plates forming a belt which may be closed at the moment of utilisation to form a circle. Such a core opens and closes at will as often as required and fulfills perfectly the requirements of flexibility, adaptability and capability of introduction into narrow spaces indispensable for certain operations.

These magnetic cores faithfully serve the purposes for which they were designed; that of having their clamps articulated in order to embrace the cables to be detected, constituting jointed links, whether or not the magnetic core is provided with an appropriate wattmeter or volt meter incorporated in the articulated belt and operating as a clamp.

It has been found in practice that the detection of the magnetic flow to be measured in the cable in question some times presents difficulties, as far as application is concerned.

At present, some magnetic cores on the market are provided with an electric coil to adjust the magnetic flow created around it in direct porportion to the passage of the current along the cable. This electric coil is placed in any part of one or other of the arms of the clamp and as these arms are in one piece, the work of the electric coil covers the entire length of the arm but in the magnetic coil referred to above this cannot be effected in the same way since, as it is composed of links which constitute independent parts united by articulati ns one after the other, a single electric coil is not satisfactory as th links which are at a distanc from the point at which th coil is situated would be out of the range of action thereof.

When, in addition, it is necessary to shi ld the coil for the reason already mentioned, a one-piece shield cannot be used.

In addition, the problem exists of the disposition of the connecting cables from the coils to the parts involved.

Bearing in mind that the core is articulated, the wiring connecting of the coil will be subject to constant cross-strain bending which, after a little use, would break the wiring, interrupting the connection.

The object of the invention is to solve thes problems.

The invention will be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 shows an articulated, curved belt which forms the body of the flexible magnetic core, without the connecting heads on the belt ends, the last sections of the belt being shown disconnected so that it can be seen how they are joined to one another;

Figure 2 shows the metallic plates, multiple juxtaposition of which forms the magnetic core, three plates being shown separated;

Figure 3 is a cross sectional view of the joining together of several plates continuously and in operlapping relation;

Figure 4 is a view in section, showing the protection for the plates and how the articulation is achieved;

Figure 5 is a detail of the foregoing without showing the articulation, the plates being seen in cross section and only a part of the thickness of the core being shown;

Figures 6 and 7 show the coupling heads, in this case magnetic, for the ends of the belt which forms the core, which heads serve to close the belt to form a circle;

Figure 8 is a cross section through a magnetic core provided with protecting coils; and

Figure 9 is a section on the line II–II in Fig. 8.

The core is formed of substantially rectangular magnetic plates 1, one of the ends of each of which protrudes and the opposite end is inset, preferably curved. Each magnetic plate has three holes 2 which pass through it, one near each end and the third approximately at its centre.

These plates 1 are arranged continuously one after another to form a chain with the male end 3 or female end 4 of one overlapping the f male end 4 or male end 3 of the other immediately adjacent.

In consquence, an articulated belt is obtained, formed by the juxtaposition of the separate rows which are articulated and all secured together by transverse joining and articulating rivets 5, in addition, these plates 1 being united and articulated to one another

by hinging rivets passing through the holes 2 in the plates 1 when the positions of the holes 2 coincid on overlapping of the ends, and these in turn, are superimposed on other rows of identical plates 1. These are connected to one another by joints, also respecting the alternating placement, in order that the projection which occurs due to the overlapping of the ends of a row, can be compensated by entering the central part of the upper and lower superimposed rows of the latter, which in turn fit into the central part of the former.

In consequence an articulated chain is obtained, formed by the juxtaposition of several articulated rows, all of them joined by transverse hinging rivets.

Each of the different metallic elements which constitute the chain of the magnetic core are protected dielectrically from damp, dust, acids, alkalis and destructive atmospheric agents.

For this purpose, both the front and back face of the chain are covered with a sheath of dielectric flexible material 6 such as a polyamide.

Each sheath 6 all of which are identical, consists of a body moulded from flexible dielectric material, such as a polyamide, of an appropriate substantially rectangular form. One of its ends 7 is curved and the opposite end is provided with two parallel flexible lateral plates 8 and 9, the former being longer than the latter. Between these two plates there is provided a semicircular element 10 in the centre of which is an orifice 11.

The inner surface of the sheath 6 is cut away in order to leave a long intermediate passage 12 between the edge of the sheath and the edges of the plates, into which passage are slipped the flexible lateral plates 8 and 9 of the immediately preceding part. The passages 12 each have a stop 13 at the end opposite to that entered by the lateral plates 8 and 9 and the length of the passages is greater than that of the parts of the lateral plates 8 and 9 inserted therein.

The ends of the lateral edges and the terminations of the passages are angled in such a way as to create a socket 14 for the semicircular end 7 of the rear part of the next sheath and a stop 15 for the lateral plates of the next preceding part permits a gap 16 at the opposite side which, by virtue of bending the lateral plate 8 inserted at that side, enables one part to be inclined relative to the next.

In the centre of the part moulded from dielectric material, a ledge is provided to house the projecting heads of the rivets joining the metallic plates and in addition, the articulation shaft of the rivet 5 for each appropriate section or area of the chain is introduced into the orifice provided in the end f the preceding part with which it remains joined by articulation, at this point to said turning shaft, forming a body with the chain, while the oppositve end enters a notch 18 in the outside of the semi-circular end 10 of the preceding part.

With this arrangement, the insulation joint between the metal plates which form the magnetic core is labyrinthine, since, in spite of the fact that part of the covering remains exposed, this does not affect the impermeability of the metal sheets, as even if part of the joint of the covering remains exposed, by virtue of the existence of the flexible lateral plates 8 and 9 of a part which enters the long housing of the immediately preceding part, the part which would have been left exposed is covered.

In order to join the ends of the chain and so close the circle at the moment of use extended surface contact is necessary between the links at the opposing ends of the chain, permitting the passage of a strong magnetic flow which would not be possible if contact was made at a single point. Since the front portions of the plates 1 are blunt and contact is only made at a tangent, terminals 19 are placed at the ends of the chain.

When it is desired that the connection be made by simple magnetic adherence then identical terminals 19 are provided at each end, both formed in one piece and each provided with a casing 20 which is closed on all sides except one. In each casing a permanent magnet 21 is housed with two iron pole pieces.

These pole pieces are secured by adhesiv in the mouth of each respective casing.

The ends of the chain forming the core ar inserted with the plates vertical in the central housing of each terminal 19.

In these ends the hinging rivets do not allow articulation in order to ensure that the assembly of magnetic plates remains compact and rigid. The rigidity and the union with the housing is enhanced still more by employing adhesives.

Once the gluing and polymerising has been carried out a perpendicular cut is made. Cutting is effected in order to level and smooth all the heads of the plates at the end of the chain to bring them flush with the sides of the face of the terminal.

For this purpose, the perpendicular cut is effected at a point at each end of the chain, which point is so located that once said cut has been effected all the ends of the magnetic plates are visible and not just the ends of alternate plates.

The teminals with the lateral plates visible from the ends of the chain fac one anoth r and are joined at their forward ends so that the body of the chain forms a circle and all the heads of the terminal plates contact the heads of the plates of the opposite terminal.

The pole pieces which have previously been placed in position and act as permanent magnets, are ground so as to locate the point f

cut of the magnetic core heads at the same l vel in order that the whole assembly remains smooth.

It should be borne in mind on installing the permanent magnets that these have different polarities in order to thus double the cohesive force of the magnet and obtain predetermined automatic positioning on opposing and at the moment of forming the temporary circle, unite the two terminals of the ends of the chain which can be later adjusted, if necessary, with the fingers.

In this way, the magnetic core is complete, composed of plates, lineal, articulated, insulated and with breach of continuity on effecting the union of its ends by magnetic or other appropriate contact.

When it is wished to put the electric coil in action in order to adjust the magnetic flow created in it in direct proportion to the passage of the current along the cable, instead of placing a general electric coil, an electric coil 22 is situated in each one of the links 1 which form the determinative chain of the magnetic core and the total sum of same, thus distributed, gives the exact and uniform detection of the current which passes through the cable and which is measured independently of this cable's position in an interior space embraced by the magnetic core detector and the cables 23 connecting one coil to the one immediately following it, are inserted through the transverse articulating shafts 5 of the immediately following links 1, for which reason the slid shafts of the first embodiment are substituted by tubular ones, as a result of which, the cable connecting the coils operates mechanically by torsion.

When it is necessary to give appropriate magnetic, electric, mechanical or other shielding to the coil 22 situated in each link 1, then, parallel to same a small metallic plate 24 of suitable material is placed in each link 1 of sufficient length to ensure the protection of the coil and in such a way that the ends of each protective plate 24 do not impede the free articulation of one link 1 in relation to the one immediately following.

It is understood that details of construction which do not alter, change or modify the scope of the invention, may be varied within the scope of the appended claims.

CLAIMS

1. A magnetic core in the form of a chain or belt, comprising a plurality of articulated links and coupling heads for connecting together the links at opposite ends f the chain or belt, electrically and mechanically to form a closed ring, wherein each link comprises a plurality of metal plates ext nding longitudinally of the chain or belt in a row across the chain or belt and pivotally connected to each other and to the plates of adjacent links by transverse rivets passing through registering ap rtures in said plates, each plat has substantially conv x and concave ends which match the associated ends of the plat s in adjacent links and alternate plates in each row are reversed and staggered with resp ct to the others in the row so that the convex end of one plate overlaps the convex ends of the adjacent plates on each side thereof.

2. A magnetic core according to Claim 1, wherein each insulating housing is an open-ended case moulded from synthetic plastics material and comprising two parallel longitudinally extending side walls one end of each being substantially convex and the other being formed with a longitudinally extending rabbet, the inner end of which is substantially concave to receive the overlapping convex end of the corresponding side wall of the next link, and two cross walls one of which is longer than the other and both of which have end portions of reduced thickness which project beyond the convex ends of the side walls, said cross walls being cut away internally of the housing to form longitudinally extending channels which receive the projecting ends of the cross walls on the adjacent link.

3. A magnetic core according to Claim 2, wherein said internal channels terminate short of the rabbetted ends of the side walls and are longer than said projecting end portions of said cross walls to compensate for differ nt degrees of pivoting movement between adjacent links.

4. A magnetic core according to Claim 2 or 3, wherein the shorter of each two cross walls on one link is provided, at the junction between its main and projecting portions, which a shoulder formed with an inclined abutment for engagement by the non-reduced end of the corresponding cross wall on the adjacent link when the latter is pivoted to its full extent relative to said one link.

5. A magnetic core according to any one of Claims 2 to 4, wherein the rabbetted end portion of each side wall is formed in its inner surface with a recess which receives on end of one of the rivets connecting the plates of one of the links, the other rivets for said links extending freely into a longitudinal passage which receives the rabbetted end portion of the adjacent link and is formed by cutting away the inner surface of said wall between the rabbetted end portion and the convex nd.

6. A magnetic core according to any preceding claim, wherein said coupling heads are moulded from synthetic plastics material and contain metal plates which are secured by rivetting to the plates in said end links.

7. A magnetic core according to Claim 6, wherein each coupling head contains a permanent magnet secured therein by adhesive, for effective magnet coupling of said heads.

8. A magnetic core according to Claim 7, wherein the plates of said end links are rigidly secured to the plates in said coupling heads

by rivetting.

9. A magnetic core according to Claim 7 or 8, wherein the plates in each coupling head ar arranged in the same way as the plates in said links and the plates are so cut that the outer ends of all the plates end flush with each other so that all the plates in one coupling head make contact with the corresponding plates in the other coupling head when the heads are united.

10. A magnetic core according to any one of Claims 7 to 9, wherein the pole pieces of each permanent magnet end flush with the outer ends of the plates in each coupling head.

11. A magnetic core according to any preceding claim, wherein each link contains an electric coil and one of the rivets connecting the plates in each link is made hollow for the passage of a cable connecting the coil in one link to the coil in the adjacent link.

12. A magnetic core according to Claim 11, wherein each electric coil is shielded by a plate of suitable material placed in each link, said plate being of sufficient length to ensure protection of the coil without impeding free articulation of the link.

13. A magnetic core substantially as hereinbefore described with reference to and as shown in Figs. 1 to 7 or Figs. 8 and 9 of the accompanying drawings.

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